MOTOROLA INC. COMMUNICATIONS DIVISION • **INSTRUCTION MANUAL**

**MOTOROLA** PRECISION INSTRUMENT PRODUCTS

# Frequency Standard

## MODEL S1076BR

68P81048A15-O

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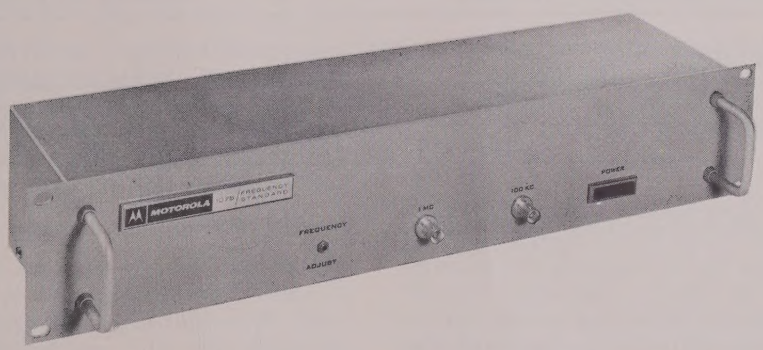
MOTOROLA

# 1010 FREQUENCY STANDARD

MODEL S1075BR




**MOTOROLA INC.** *Communications Division*

ENGINEERING PUBLICATIONS 4501 WEST AUGUSTA BOULEVARD CHICAGO, ILLINOIS 60651

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8/12/66-UP

68P81048A15
Issue - O

## GUARANTEED PERFORMANCE SPECIFICATIONS

| | |
|---|---|
| OUTPUT FREQUENCIES | 1 MHz and 100 kHz at 1 volt rms sine wave into 50 ohms |
| STABILITY $\triangle$ F (MAX.) | Spectrally pure 5 MHz output optionally available (rear panel) |
| versus: F | |
| Input Voltage Change ±10% | Less than $\pm 5 \times 10^{-10}$ |
| Load Resistance Change ±10% | Less than $\pm 2 \times 10^{-10}$ |
| Ambient Temperature 0°C to +50°C | Less than $\pm 1 \times 10^{-10}$/C° |
| TIME 24 hr.: | Less than $1 \times 10^{-9}$ (10 day average) |
| Short term (10 sec.avg. time): | Less than $1 \times 10^{-10}$ |
| FREQUENCY ADJUST RANGE Coarse: | $\pm 2 \times 10^{-6}$ minimum (internal tuning tool adjustment) |
| Fine: | $1 \times 10^{-7}$ total (front panel screwdriver adjustment) |
| DISTORTION | Less than 2% into rated load |
| INPUT VOLTAGE | 115 v ac ±10% or 230 v ac ±10% 50-60 Hz |
| POWER CONSUMPTION | Less than 10 watts at room temperature |
| CIRCUITRY | Proportional control oven, zener regulation, silicon transistors |
| OPERATING TEMPERATURE RANGE | 0°C to +50°C |
| OUTPUT CONNECTORS | Standard BNC type (terminate in 50 ohms) |
| SIZE AND WEIGHT | 19" wide x 3-1/2" high x 4-1/2" deep. Approximately 10 lbs. |

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

# FOREWORD

## CLAIM FOR DAMAGE IN SHIPMENT

If any damage to the shipping container is apparent upon receipt, the deliverying driver should be requested to note such damage on all copies of the freight bill. This is for your protection should the material have sustained damage.

The equipment should be unpacked immediately, examined for damage and tested. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. The claim should be filed within forty-eight hours after receipt, if possible, or during a period not to exceed fifteen days.

A full report of such damage should be obtained from the claim investigator, who will call upon you. For the purpose of this report, the shipping container and all packing materials should be retained for the investigator to examine.

The investigator's report should then be forwarded to:

Motorola Communications &
Electronics, Inc.
Precision Instrument Products
4900 West Flournoy Street
Chicago, Illinois 60644

Include model number and serial number when referring to the instrument for any reason.

Arrangements for repair or replacement will be made and you will be advised of the disposition of the instrument.

## REPAIR AND/OR RECALIBRATION

If desired, the instrument may be returned to:

Motorola Communications &
Electronics, Inc.
Precision Instrument Products
4900 West Flournoy Street
Chicago, Illinois 60644

for repair and/or recalibration. Before shipping the instrument notify the Precision Instrument Products Department at the above address of the service required. Refer to the instrument by model number and serial number. On receipt of this information, you will be informed of shipping instructions. If requested, an estimate of the charges will be made before work begins, provided the instrument is not covered by the warranty.

## SHIPPING

The instrument should be surrounded by two or three inches of excelsior or similar shock absorbing material and then packed in a strong exterior container. It should be shipped via truck, railway express, air freight or air express.

# WARRANTY

This instrument is guaranteed by Motorola, for a period of one year after delivery to the original purchaser, against defects in design, material, and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory Service Department for that purpose and to replace any defective parts thereof.

This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at the net price of necessary parts and a service charge at Motorola's then prevailing labor rate. In this case, an estimate will be submitted before the work is started.

This warranty is in lieu of all other warranties, expressed or implied and all other obligations or liabilities on Motorola's part.

If any fault develops, the following steps should be taken:

1. Notify us at the following address:

   Motorola Communications &
   Electronics, Inc.
   Precision Instrument Products
   4900 West Flournoy Street
   Chicago, Illinois 60644

   Give full details of the difficulty, and include model number and serial number. On receipt of this information, we will give you service data or shipping instructions.

2. On receipt of shipping instructions, forward the instrument prepaid to the above address or to the authorized repair station indicated on the instructions. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the warranty.

## 1. INTRODUCTION

The Model S1076BR Frequency Standard is a rack mounted, all solid-state (silicon) instrument that provides highly stable 1 MHz and 100 kHz output signals. Stability is maintained over a wide range of ambient temperatures by enclosing the crystal in a precision oven.

## 2. DESCRIPTION

The unit consists of a single oven high stability oscillator, a 1 MHz isolation amplifier, a 1 MHz to 100 kHz divider circuit and a power supply.

The basic accuracy of the unit is determined by a precise, glass enclosed crystal which is maintained accurately to a given temperature in the 80° C region. Provision is made for adjusting the internal crystal frequency without removing the unit from its case.

A glass piston capacitor is used for the fine frequency adjustment of the oscillator and a variable inductor is used for the coarse frequency adjustment. The inductor is housed inside the oven and has a screwdriver adjustment. The capacitor is rigidly mounted to the front panel and is tuned by a screwdriver adjustment on the front panel. The fine frequency tuning range is approximately 1 part in $10^7$.

A voltage regulator in the power supply insures stable operating voltage. An overload protection circuit prevents momentary short circuits from causing damage to the semiconductors in the power supply. A red lamp on the front panel provides an indication that ac power is applied to the unit.

## 3. INSTALLATION

a. 115 V AC Operation

Connect the ac line cord to a 115-volt, 50-60 Hz, ac convenience outlet. The red indicator lamp on the front panel will light. The use of an exclusive 24-hour ac line will protect the unit from accidental shutdown during non-working hours and from power failures resulting from temporary overloads by other equipment.

b. 230 V AC Operation

Unless specifically ordered for 230 v ac operation, the unit is shipped from the factory for 115 v ac operation.

***CAUTION***

Before attempting 230 v ac operation, the transformer primary circuit must be wired as shown on Schematic Diagram 63D81048A16 for 230 v ac operation.

c. Output Connections

Separate BNC type connectors are provided on the front panel for the 1 MHz and 100 kHz outputs. The unit is capable of a 1-volt output into a 50-ohm resistive load.

For units with the spectral purity output option, a BNC type connector is located at the rear of the unit for 5 MHz output. It will supply one volt rms into a 50-ohm resistive load.

## 4. THEORY OF OPERATION

a. General

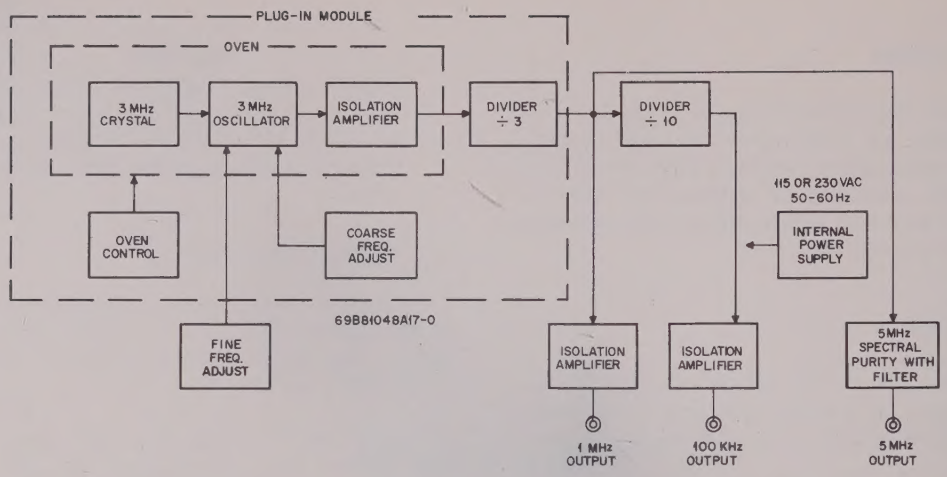
Refer to Block Diagram 69B81048A17 and Schematic Diagram 63D81048A16.

A 3 MHz glass enclosed crystal was selected as being well suited to provide good stability and low aging over a long period of time. A transistor oscillator employing stabilized circuitry and low drive level for the precision crystal is used to insure the utmost in performance. An isolation amplifier provides isolation of the oscillator circuitry from external load effects. A high-gain, proportional-control oven circuit maintains the crystal at a predetermined temperature. A fail-safe 3:1 divider circuit, controlled by the 3 MHz crystal, provides the 1 MHz oscillator output.

A fail-safe divider circuit produces the desired 100 kHz output frequency. A power supply incorporating a stable, solid-state regulator is used to eliminate the effects of voltage variations on the output frequencies.

b. Oscillator

Oscillator transistor parameters are relatively temperature and age insensitive. It operates at low power levels with low noise, since noise contributes to short-term instabilities. Furthermore, the transistor has a high ratio of maximum frequency to operating frequency to insure little phase shift through it. Changes in phase shift due to aging and other variations consequently, are also small.




S1076BR Frequency Standard Block Diagram

c. Output Signal Circuits

A 1 MHz output from the oscillator is coupled to the isolation amplifier circuit of Q101. Capacitive taps in the tuned circuit of this transistor apply the signal to the 1 MHz output connector at the front of the frequency standard.

The 100 kHz output signal is derived in the 1 MHz to 100 kHz divider circuit. A 1 MHz input signal from the oscillator is applied to the isolation amplifier circuit of Q201. The amplified 1 MHz signal is then fed from the capacitive tap in the tank circuit of Q201 to the base of Q202 to provide gating of locked oscillator Q203. The tank circuit of Q203 is tuned to 100 kHz. The emitter of Q203 provides a 100 kHz signal to the base of Q204 which is the 100 kHz output isolation amplifier. The signal is then coupled from the collector circuit of Q204 to the 100 kHz output connector on the front panel. In the absence of a 1 MHz input signal, locked oscillator Q203 is biased to cutoff for fail-safe operation.

d. 5 MHz Multiplier and Crystal Filter

A 1 MHz signal taken from pin 6 of J101 is fed to input emitter follower Q301 and then to x5 multiplier Q302. The amplified 5 MHz output signal is applied to amplifier Q303 and the resultant output is filtered by the circuit consisting of crystal Y301 and associated capacitors which has a bandpass of approximately 30 Hz. The output of the filter is amplified by Q304 and coupled to the 5 MHz connector via the double-tuned output circuits. The 5 MHz output signal level is regulated by rectifiers CR301 and CR302 which supply an AGC control voltage to amplifier Q303.

e. Power Supply

The frequency standard operates from a 50 to 60 Hz, single-phase primary source of 115/230 volts, ac. The power supply delivers 28 v dc from an electronic regulator with a capacity sufficient to operate the unit.

Transformer T1 supplies primary ac to the bridge rectifier consisting of CR1, CR2, CR3 and CR4. Approximately 40 v dc is impressed across filter capacitor C3 and applied to the regulator circuits.

Transistor Q1 functions as a series regulator, and Q2 senses and regulates the output voltage. Zener diode CR5, via Q2, establishes a fixed voltage reference level. Q2 utilizes this reference level at its emitter to sense power supply output voltage changes appearing across R4 and R5. DC changes at the base of Q2 are therefore amplified and, with Q2 collector connected to the base of Q1, change the base voltage which results in a voltage change at the emitter of Q1.

Momentary short circuits across the power supply output will not damage the unit. During a short circuit, load current is limited by design of the regulator to 1 ampere.

LINE fuse F1 is located at the rear and is accessible from outside the unit.

## 5. MAINTENANCE

a. General

This instrument should be serviced by personnel qualified in maintaining laboratory test

equipment. It is an accurate, sensitive device and should be treated as such. When qualified personnel or adequate test equipment are not available, the equipment should be returned to the factory for service or recalibration. Refer to the FOREWORD for detailed instructions.

b. Dust Cover Removal

To gain access to the interior of the unit, remove two screws from either end of the unit and lift the cover toward the rear.

c. Calibration and Adjustments

Periodic calibration adjustments against a known frequency standard should be made. Should the instrument fail to respond to the adjustments in the manner described, the possibility of a malfunction in the high stability oscillator unit is indicated. Do not attempt to service the unit. It must be returned to the factory for repair.

For fine frequency adjustment, the FREQUENCY ADJUST screwdriver adjustment located on the front panel provides a frequency range of approximately 1 part in $10^7$. Clockwise rotation produces decreasing frequency. Mechanical stops are provided at either end of the adjustment, but care should be exercised to prevent damage to the capacitor stop mechanism. If further change of frequency is desired, the COARSE adjust control must be used.

For coarse frequency adjustment, the COARSE frequency adjustment screwdriver control is used. This control is accessible by removing the unit dust cover. Before adjusting this control, the fine FREQUENCY ADJUST control should be rotated two or three turns from the full counterclockwise position if the oscillator was aging upward, or two or three turns from the full clockwise position if the osciliator was aging downward. The COARSE frequency adjustment is made by inserting the small blade of the tuning tool provided into the hole located at the top of the plug-in oscillator module. Rotation of the control in the counterclockwise direction increases frequency; rotation in the clockwise direction decreases frequency.

d. Power Supply Test

The power supply maintains an output voltage of approximately 28 volts to within ±0.5 volt for input voltages of 115/230 vac ±10%. If a component has been replaced, it is necessary to check the voltage regulation before returning the unit to service. To do this, vary the input voltage with a "Variac" between 105 and 130 v (210 and 260 v if nominal voltage is 230 v) ac, and check the output voltage of the power supply with a voltmeter. If proper regulation is taking place, the output voltage will not vary more than ±0.5 volt.

e. General Alignment Considerations

The frequency standard requires very little maintenance. Transistors, being inherently reliable devices, do not normally require replacement for the life of the instrument. Should it become apparent that realignment is necessary, use the procedure outline in this section.

Test equipment for this purpose should be of laboratory quality and subject to scheduled preventive maintenance and calibration.

f. 1 MHz Isolation Amplifier Alignment Procedure
(Refer to Circuit Board Detail PEPD-10871)

(1) Connect a 50-ohm resistive load to the 1 MHz output connector.

(2) Connect the vertical input of an oscilloscope to the 1 MHz output connector. Trigger the oscilloscope internally.

(3) Adjust C103 for a maximum undistorted waveform on the oscilloscope. The output voltage should be at least 1.0 volt, rms.

g. 1 MHz to 100 KHz Divider Alignment Procedure
(Refer to Circuit Board Detail PEPD-10872)

(1) Connect a 50-ohm resistive load to the 100 kHz output connector.

(2) Connect the oscilloscope horizontal external sweep to the 50-ohm load and the vertical sweep (input) to the 1 MHz output connector.

(3) Adjust the slug of L202 for a 10:1 Lissajous figure. If not enough output signal is obtained to produce a usable Lissajous figure, the slug of L203 may be adjusted.

(4) Repeat step (3) until the slugs of L202 and L203 are adjusted for optimum operation.

(5) Connect the vertical input of the oscilloscope to the 100 kHz output connector. Trigger the oscilloscope internally.

(6) Adjust L203 for a maximum undistorted waveform on the oscilloscope. The output voltage should be at least 1.0 volt, rms.

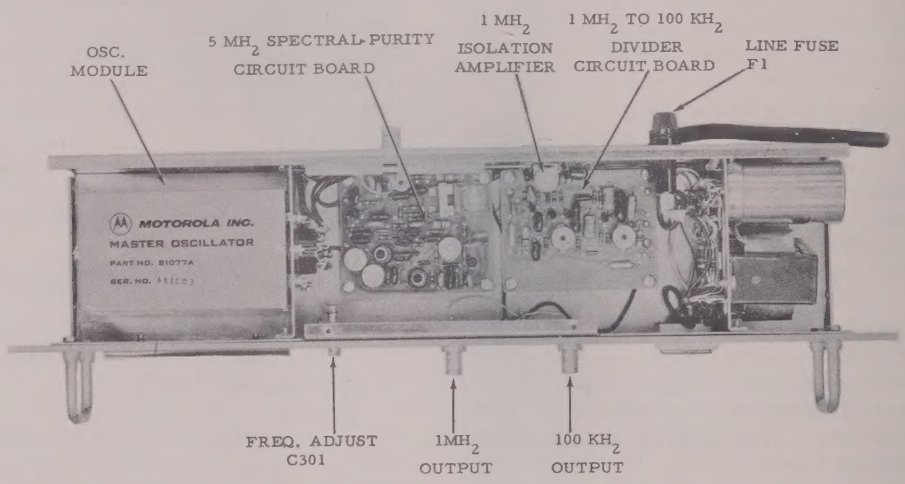
h. 5 MHz Multiplier and Crystal Filter Alignment Procedure
(Refer to Circuit Board Detail PEPD-9821)

The adjustment for this module requires only that its tuned circuits be periodically peaked since the bandpass of this circuit is controlled primarily by the "Q" of crystal Y301.

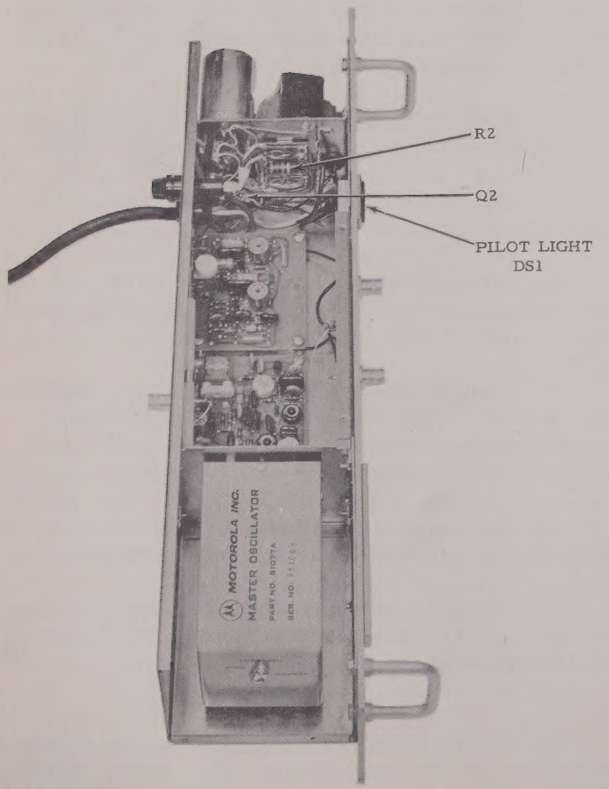
(1) Place a dc voltmeter probe at the junction of C317, CR301 and CR302. Connect a 50 ohm resistive load and an oscilloscope probe at the 5 MHz output jack (J3).

(2) Adjust L302, C312 and C320 for minimum dc voltage and maximum r-f output voltage. Adjust C323 for maximum r-f output voltage.

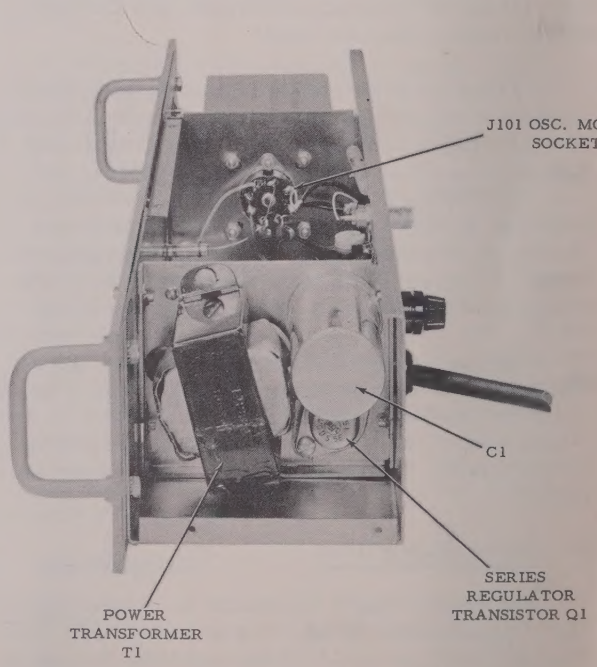
(3) Repeat step (2) for maximum r-f output voltage. It should be a minimum of 1 v, rms at 5 MHz.



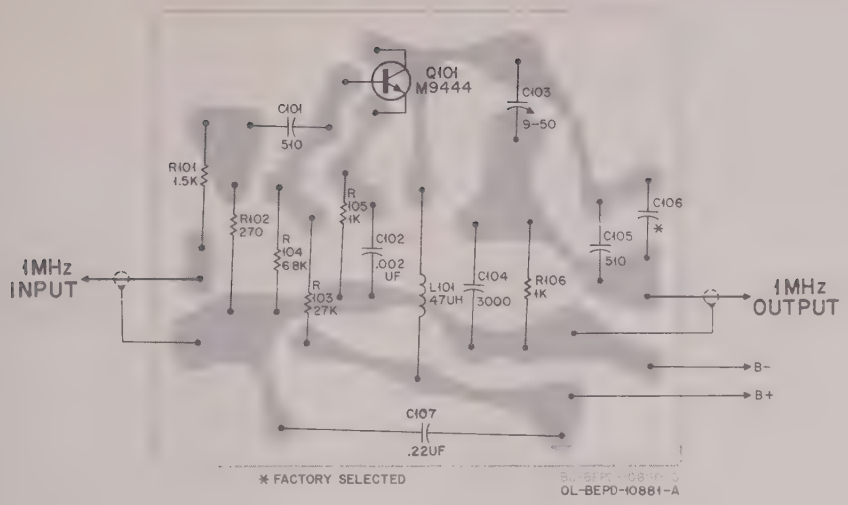

Parts Location Detail - Top View



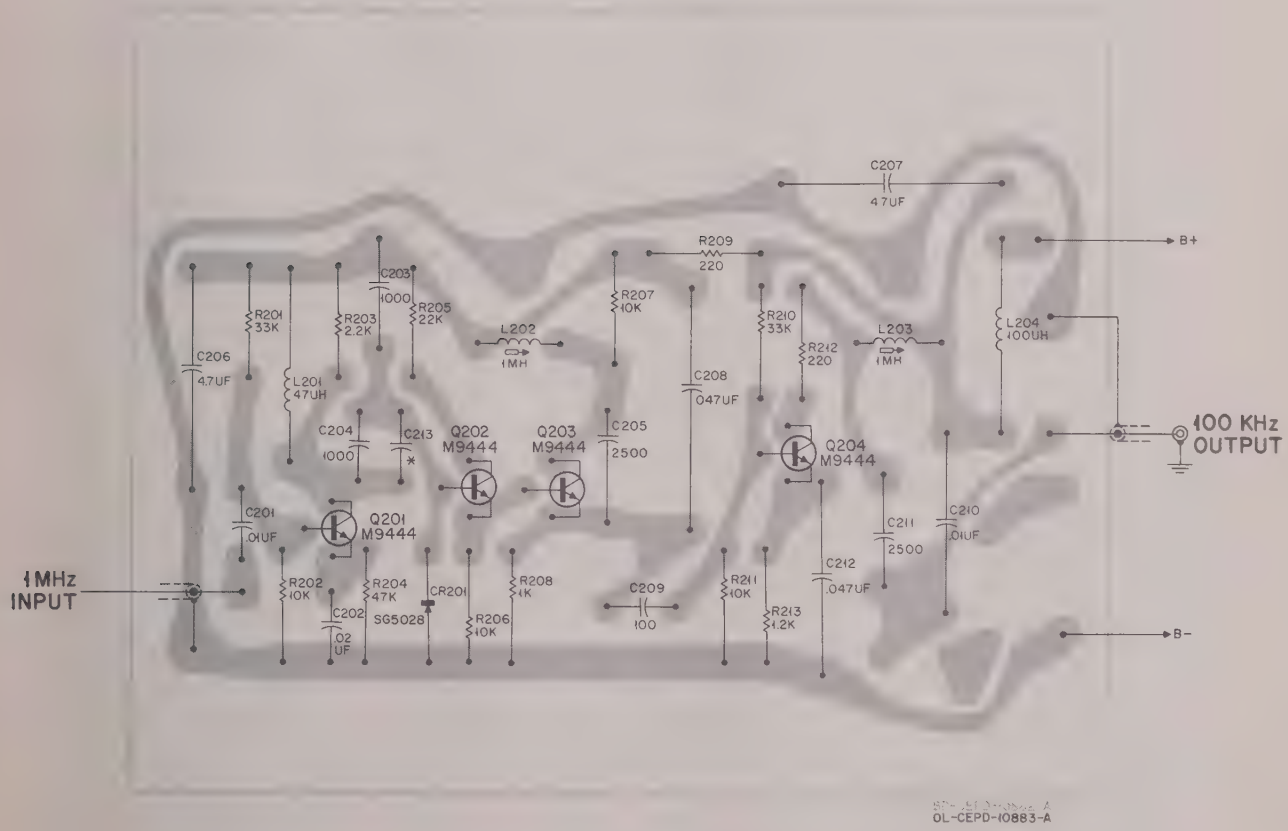

Parts Location Detail,
View From Top Left



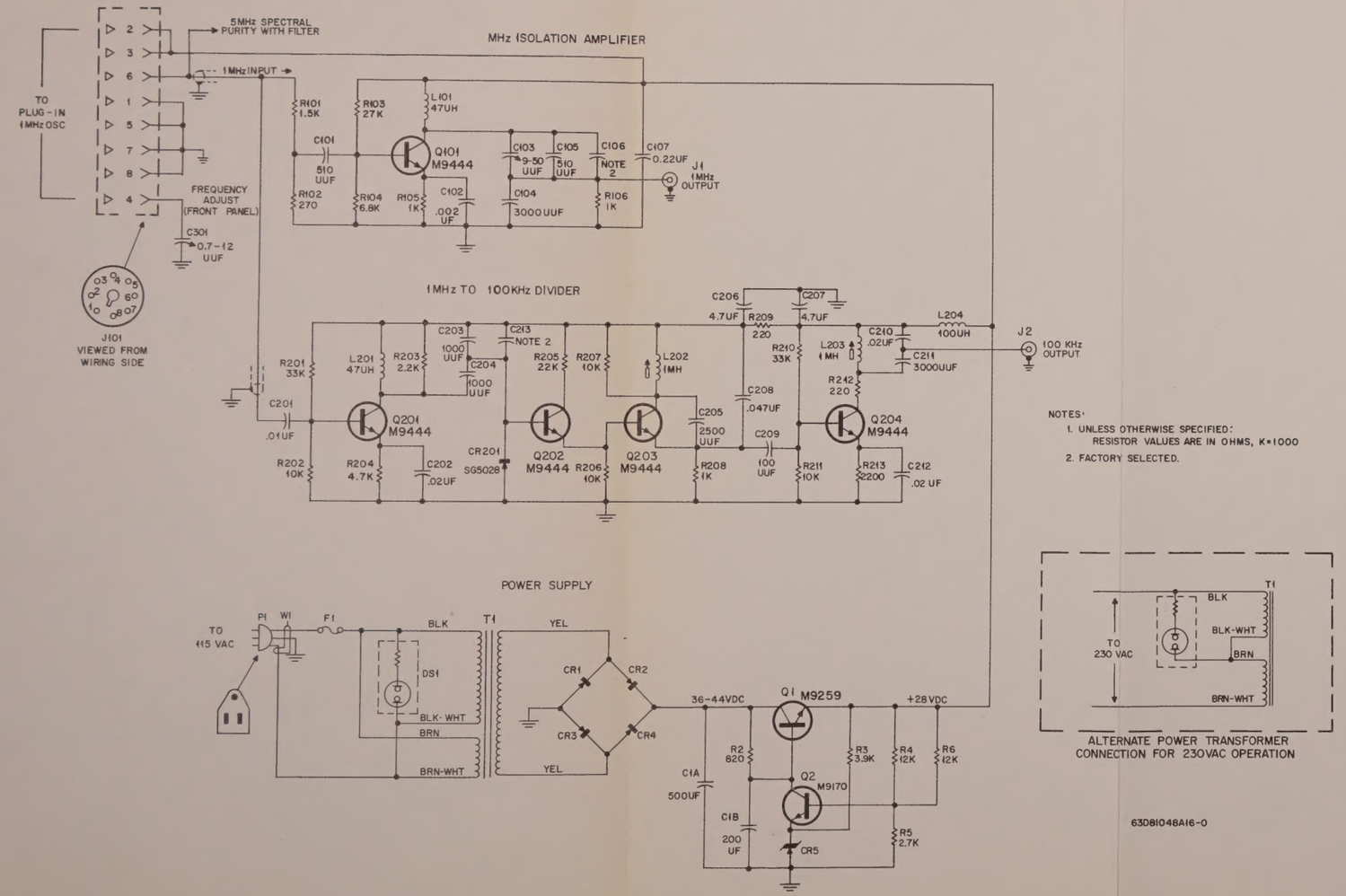

Parts Location Detail,
View From Top Right




1 MHz Isolation Amplifier
Circuit Board Detail, PEPD-10871-A




1 MHz to 100 KHz Divider
Circuit Board Detail, PEPD-10872-A




NOTES:

1. UNLESS OTHERWISE SPECIFIED: RESISTOR VALUES ARE IN OHMS, K=1000
2. FACTORY SELECTED.

PARTS LIST for Schematic Diagram 63D81048A16-O

Frequency Standard, Economy Model

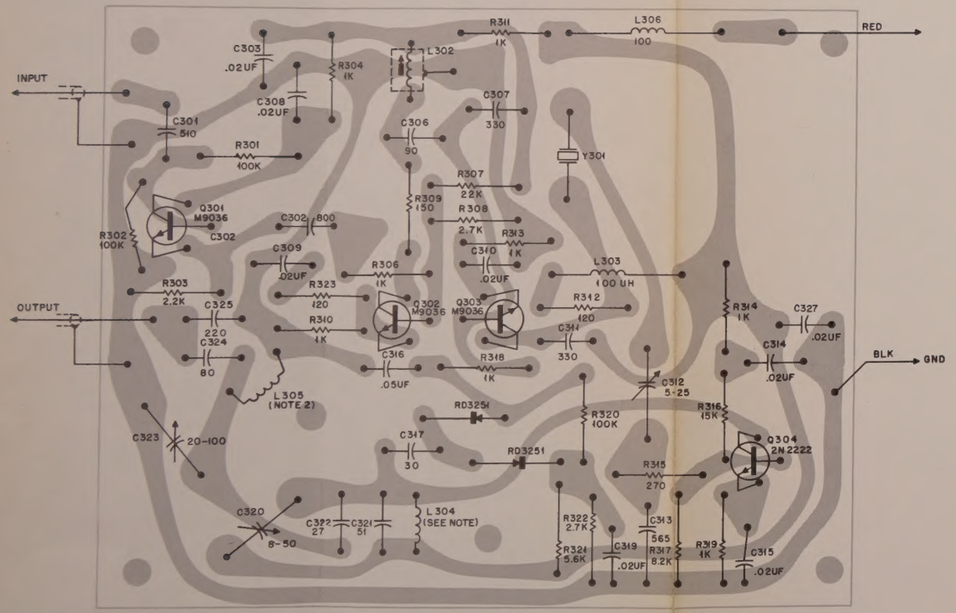
| REFERENCE SYMBOL | MOTOROLA PART NO. | DESCRIPTION |
|---|---|---|
| | | CAPACITOR, fixed: |
| C1 | 23D82125B16 | 2 section; c/o: |
| C1A | | ⏢ 500 uf +100-10%; 75 v |
| C1B | | △ 200 uf +100-10%; 75 v |
| C101, 105 | 21K845214 | 510 uuf ±5%; 300 v |
| C102, 202 | 21K832502 | .02 uf +60-40%; 250 v |
| C103 | 20C82860B01 | var; 9-50 uuf ±1.5 to +7% @ -55°C -5 to -1.5% @ +85°C; N750; 350 v |
| C104, 211 | 21K850994 | 3000 uuf ±5%; 500 v |
| C106 | | factory selected |
| C107 | 8K868594 | 0.22 uf ±10%; 100 v |
| C201 | 21D8242B12 | .01 uf +70-30%; 100 v |
| C203, 204 | 21K863291 | 1000 uuf ±5% |
| C205 | 21K859773 | 2500 uf ±5%; 500 v |
| C206, 207 | 23D82783B11 | 4.7 uf ±10%; 35 v |
| C208, 212 | 8D82905G17 | .047 uf ±10%; 100 v |
| C209 | 21K865446 | 100 uf ±3%; 500 v |
| C210 | 8C82987E01 | .01 uf |
| C301 | 20D82255H02 | var; 0.7-12 uuf |
| | | SEMICONDUCTOR DEVICE, diode: SEE NOTE |
| CR1 thru 4 | 48C82466H04 | silicon; diode |
| CR5 | 48D82256C19 | silicon; zener |
| CR201 | 48C82420C05 | diode, silicon |
| | | LAMP, neon: |
| DS1 | | RED; p/o XDS1 |
| | | FUSE, cartridge: |
| F1 | 65R21975 | 1/2 amp; 250 v |
| | | CONNECTOR, receptacle: |
| J1, 2 | 9B855268 | female; single cont.; type UG-657/U |
| J101 | 9K6740 | female; 8 cont. |
| | | COIL, RF: |
| L101, 201 | SPC24A1010A03 | 47 uh |
| L202, 203 | SPC24B1007A01 | var; 1 mh |
| L204 | SPC24A1010A02 | 100 uh |
| P1 | | CONNECTOR, plug; male; 3 cont; p/o ref part W1 |
| | | TRANSISTOR: SEE NOTE |
| Q1 | 48R869259 | N-P-N; type M9259 |
| Q2 | 48R869170 | N-P-N; type M9170 |
| Q101, 201, 202, 203, 204 | 48R869444 | N-P-N; type M9444 |
| | | RESISTOR, fixed: ±10%; 1/4 w; unl stated |
| R2 | 6S2046 | 820 ±10%; 2 w |
| R3 | 6S5659 | 3.9K ±10%; 1/2 w |
| R4, 6 | 6S2075 | 12K ±5%; 1/2 w |
| R5 | 6S5652 | 2.7K ±5%; 1/2 w |
| R101 | 6K127803 | 1.5K |
| R102 | 6K129752 | 270 |
| R103 | 6K127806 | 27K |
| R104 | 6K128687 | 6.8K |
| R105, 106, 208 | 6K127802 | 1K |
| R201, 210 | 6K127807 | 33K |
| R202, 206, 207, 211 | 6K129225 | 10K |
| R203 | 6K128689 | 2.2K |
| R204 | 6K127804 | 4.7K |
| R205 | 6K128685 | 22K |
| R209, 212 | 6K127800 | 220 |
| R213 | 6K128689 | 2.2K |
| | | TRANSFORMER, power: |
| T1 | SPC25A1006 | pri: BLK, BLK-WHT, BRN, BRN-WHT; sec: YEL, YEL |
| | | CABLE: |
| W1 | 30C865903 | 3 cond; incl. ref part P1 |

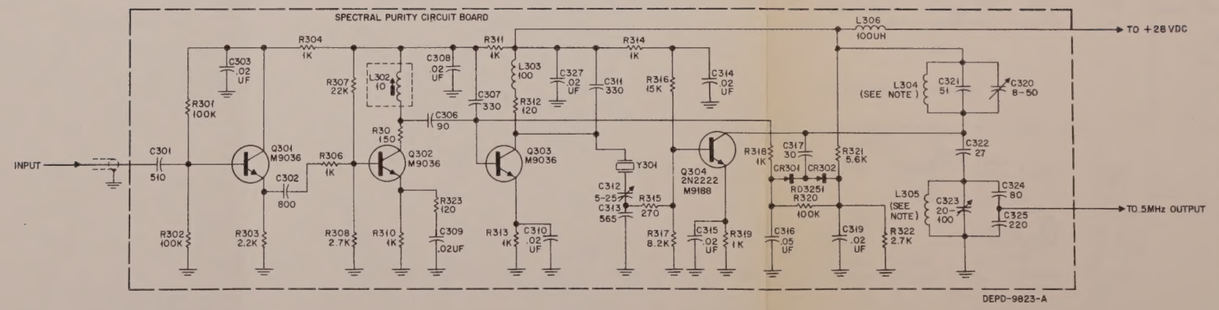
| REFERENCE SYMBOL | MOTOROLA PART NO. | DESCRIPTION |
|---|---|---|
| XDS1 | SPC65A1009 | LAMPHOLDER, neon; assy; incl. DS1 |
| XF1 | 9B865564 | FUSEHOLDER: extractor post type |
| XF2 | 3K867759 | clip type |

NOTE:

Replacement diodes and transistors must be ordered by Motorola part number only for optimum performance.

Model S1076BR Frequency Standard
Schematic Diagram
Motorola No. 63D81048A16-O
8/12/66-UP




PARTS LIST SHOWN ON BACK OF THIS DIAGRAM

Model SLN6089A Spectral Purity Circuit Board Detail
Motorola No. PEPD-9821-A
8/12/66-UP



## PARTS LIST

SLN6089A Spectral Purity Board EPD-J6621-O

| REFERENCE SYMBOL | MOTOROLA PART NO. | DESCRIPTION |
|---|---|---|
| | | CAPACITOR, fixed: uuf; unl stated |
| C301 | 21K845214 | 510 ±5%; 300 v |
| C302 | 21K840049 | 800 ±5%; 300 v |
| C303, 308, 309, 310, 314, 315, 319, 327 | 21K832502 | .02 uf +60-40%; 250 v |
| C306 | 21K865941 | 90 ±2%; 300 v |
| C307, 311 | 21K874351 | 330 ±10%; 300 v |
| C312 | 20K859643 | variable: 5-25 |
| C313 | 21K869948 | 565 ±5%; 500 v |
| C316 | 21C82372C04 | .05 uf +80-20%; 25 v |
| C317 | 21K848156 | 30 ±5%; 500 v |
| C320 | 20B847059 | variable: 8-50 |
| C321 | 21K840711 | 51 ±2%; 300 v |
| C322 | 21K847771 | 27 ±5%; 500 v |
| C323 | 20K863152 | variable: 20-100 |
| C324 | 21K847091 | 80 ±2%; 300 v |
| C325 | 21K859942 | 220 ±5%; 500 v |
| | | SEMICONDUCTOR DEVICE, diode: (NOTE) |
| CR301, 302 | 48C82617C01 | RD3251 |
| | | COIL, RF: |
| L301 | | 10 uh |
| L302 | SP24B4139-2 | variable: 10 uh ±5% |
| L303 | | 100 uh |
| L304 | | toroidal (special) |
| L305 | | toroidal (special) |
| L306 | | 100 uh |
| | | TRANSISTOR: (NOTE) |
| Q301, 302, 303 | 48R869036 | N-P-N; silicon; M9036 |
| Q304 | 48R869188 | N-P-N; silicon; M9188 |
| | | RESISTOR, fixed: ±10%; 1/4 w; unl stated |
| R301, 305, 306, 310, 311, 313, 314, 318, 319 | 6K127802 | 1K |
| R302, 320 | 6K129226 | 100K |
| R303, 321 | 6K127804 | 4.7K |
| R304 | 6K129232 | 3.9K |
| R307 | 6K128685 | 22K |
| R308, 322 | 6K128688 | 2.7K |
| R309 | 6K129862 | 150 |
| R312, 323 | 6K129617 | 120 |
| R315 | 6K129775 | 270 |
| R316 | 6K127805 | 15K |
| R317 | 6K128686 | 8.2K |
| | | CRYSTAL UNIT, quartz: |
| Y301 | type PR HC-27/U | 5 mc operation |

NOTE:

Replacement diodes and transistors must be ordered by Motorola part number only for optimum performance.